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bp (PATFORMS)

Docket: P-5534-27

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner of Patents and Trademarks
Box Patent Application
Washington, D.C. 20231

Sir:

Transmitted herewith for filing is the patent application of
Inventor: Claude Q.C. Hayes

For: FLEXIBLE THERMAL CONTROL COMPOSITE

The application comprises the following:

- ☒ Specification, Claims, and Abstract
- ☒ Declaration, Power of Attorney, and Petition
- ☒ Drawings (6 sheets)

CLAIMS AS FILED

Base Fee	- - - - -	\$	345.00
Total Claims	59-20 = x \$9.00 =		351.00
Ind. Claims	01-03 = x \$40.00 =		0
Multiple Dependencies (\$130.00)			0

TOTAL FEE \$696.00

☒ A Small Entity Statement is attached.

☒ Check No. 3066 in the amount of \$696.00 is enclosed to cover the filing and recordal fees. The Commissioner is hereby authorized to draw on the undersigned's Deposit Account No. 19-0265 if the amount paid is insufficient and if any additional fee is required during the pendency of this application. The Commissioner is also requested to deposit in said Deposit Account any amount which might prove to be in excess of the required fees.

Respectfully submitted,

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I hereby certify that this paper is being deposited with the U.S. Postal Service "Express Mail P.O. to Addressee" service under 37 C.F.R. 1.10 on the date indicated above and is addressed to: Commissioner of Patents and Trademarks, Washington, D.C. 20231.

Date: July 13, 2000

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Docket: P-5534-27

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Claude Q.C. Hayes

Serial No.:

Filed: even date herewith

For: FLEXIBLE THERMAL CONTROL COMPOSITE

Hon. Commissioner of Patents
and Trademarks
Washington, D.C. 20231VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS
UNDER 37 C.F.R. 1.9(c) AND 1.27(b) -- INDEPENDENT INVENTOR

As a below named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 C.F.R. 1.9(c) for purposes of paying reduced fees under Sections 41(a) and 41(b) of Title 35, United States Code, to the Patent and Trademark Office with regard to the invention described in the above-entitled application (Patent).

I have not assigned, granted, conveyed, or licensed and am under no obligation under contract or law to assign, grant, convey, or license any rights in the invention to any person who could not be classified as an independent inventor under 37 C.F.R. 1.9(c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 C.F.R. 1.9(d) or a nonprofit organization under 37 C.F.R. 1.9(e).

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate (37 C.F.R. 1.28(b)).

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine and imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application of any patent issuing thereon, or any patent to which this verified statement is directed.

Date: 7/12/2000
Claude Q.C. Hayes

SOLE

**APPLICATION
FOR
UNITED STATES LETTERS PATENT**

FLEXIBLE THERMAL CONTROL COMPOSITE

SPECIFICATION

To All Whom It May Concern:

Be It Known, that I CLAUDE Q. C. HAYES, a citizen of the United States residing at 3737 Third Avenue, No. 308, in the City of San Diego and State of California, have invented certain new and useful improvements in THERMAL CONTROL COMPOSITE of which the following is a specification:

Field of the Invention

5 The present invention relates to a new composition of matter, a thermal control composite comprising a polymer and an endothermic agent. The endothermic agent is distributed, dispersed and suspended within and throughout the polymer and cured to form a composite for use in insulating, thermoprotecting, heat absorbing applications on the one hand and heat maintenance applications of all types on the other.

Background of the Invention

10 All of the prior art known to Applicant teaches the use of endothermic agents in heat sinks wherein the endothermic agents are either coated, adsorbed or packed into various supporting structures.

15 For example, Applicant's first patent U.S. Patent No. 4,449,916 discloses an endothermic agent adsorbed onto the fibers of the fabric matrix.

20 Applicant's second patent, U.S. Patent No. 5,709,914 discloses an thermal storage compound packed into an open cell network, comprising natural, synthetic or metal fibers, spheres, particles, foams, or materials capable of being formed into a container suitable for enclosing and maintaining an item's high heat.

25 There are two very serious drawbacks to the prior art. First, leakage of the endothermic or thermal storage compound to the surrounding environment can occur, if the physical integrity of the various underlying supporting structures is somehow compromised. Such leakage will diminish the effectiveness of the heat sink material and may even lead to the harm and destruction of the item or material

the heat sink material is supposed to protect, particularly if the endothermic or thermal storage compounds are harsh and corrosive.

Second, the underlying structures upon which the endothermic or thermal storage compounds are coated, absorbed, adsorbed or packed tend to be stiff and inflexible. The further coating, absorption, adsorption and packing of endothermic or thermal storage compounds on and within such structures will cause them to stiffen even more. This stiffening of the material renders them entirely unsuitable in applications where the heat sink materials must be flexible and in certain situations light, thin and drapeable.

It is therefore an object of the present invention to provide a composition of matter that can act as a heat sink/heat shield, but which will resist leaking the endothermic compound into the environment, by eliminating any possibility of a compromise of the structural integrity of the underlying carrier or support structure in the heat sink material.

It is another object of the present invention to provide a composition of matter for applications requiring a heat sink/heat shield which needs to be thin, flexible, drapeable, and/or conformable, while simultaneously protecting and insulating against high or low heat environments.

It is yet another object of the present invention to provide a composition of matter for applications requiring a heat providing material which will be thin, flexible, drapeable, and/or conformable, while simultaneously protecting and insulating against extreme cold environments.

The aforementioned objects, as well as others, will be found in detail in the following written disclosure.

SUMMARY OF THE INVENTION

The inventive composition of matter is a flexible thermal control composite. Said composite comprises a polymer and an endothermic agent. The endothermic agent is dispersed, distributed, and suspended in the polymer. Thereafter it is cured to form a "P"olymer "C"ontaining an "E"ndothermic "A"gent (PCEA) composite. This composite now has thermal control properties that make it suitable for a multitude of thermal control applications.

Natural or synthetic polymer may be softened or liquified by being (1) heated, (2) dissolved or (3) suspended in a plasticizer or solvent. When the polymer treated in any of these manners has an endothermic agent added to it, in very specific concentrations, distributed, dispersed, suspended therein and cured, a thermal control composite i.e. a PCEA is formed. Such PCEA is in essence capable of thermal control through its ability to absorb and store heat or through its ability to first absorb heat and then release it. It does so through the use of its endothermic compounds' own inherent thermodynamic, physical and chemical properties, i.e. their latent heats of fusion, hydration, formation, decomposition, vaporization, sublimation, or its allotropic and phase change reactions; while simultaneously completely eliminating any possibility of leakage of its endothermic compounds into the environment, as said agents become an integral part of the PCEA overall physical structure.

Thus, according to the present invention there is provided a PCEA thermal control composite comprising a natural or synthetic polymer and an endothermic agent. The PCEA thermal control composite can be thin, as for example a thin or a thick film, or molded as a thick PCEA brick. When the PCEA is a thin film, then the effective distribution of the endothermic agents within said polymer is 0.0001 to 1.2 gram of endothermic or thermal storage compound per square inch of PCEA, the PCEA having a thickness of 0.05 to 2.0 mil. On the other hand, where the PCEA is a thick film or molded structure, then the effective concentration of endotherm will be 0.05 %-60% by weight endotherm in PCEA.

Full details of the present invention are set forth in the following description and illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

5

FIG.1 is a perspective view of a thin film PCEA formulated in accordance with the present disclosure;

FIG. 2 is a cross-sectional view taken along a line 2-2' of the thin film PCEA in FIG. 1;

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FIG. 3 is a perspective view of a thick film PCEA formulated in accordance with the present disclosure;

FIG. 4 is a cross-sectional view taken along a line 4-4' of the thick film PCEA in FIG. 3;

FIG. 5 is a schematic of an extruding apparatus used in the extrusion of PCEA fibers;

FIG. 6. is a schematic of a second type of extruding apparatus used in the extrusion of PCEA fibers;

FIG. 7 is a perspective view of a PCEA fiber formulated and extruded in accordance with the present disclosure;

FIG. 8 and FIG. 9 are top plan views of PCEA materials assembled, woven or knit using PCEA fibers;

FIG. 10 is a schematic of a delivery and adhesion method of a small particulate PCEA onto a plastic substrate.

FIG. 11 is a schematic of a delivery and adhesion method of a large particulate PCEA onto a plastic substrate.

FIG. 12 is a schematic of the delivery of a PCEA into the inner walls of a home.

FIG. 13 is a perspective view of a container incorporating one of the embodiments of the PCEA;

FIG. 14 is a somewhat schematic, perspective view of a winter or hunting jacket, incorporating a preferred embodiment of the present inventive PCEA;

FIG. 15 is a cross-sectional view taken along 15-15' of the jacket in Fig. 14, showing another use of the PCEA, in the form of a mulch;

FIG. 16 is a somewhat schematic side view of the endothermic agent in the PCEA absorbing heat, thereby preventing the heat from reaching the heat sensitive device;

FIG. 17A and FIG 17B are a somewhat schematic view of the inventive PCEA showing the recyclable endothermic agent first absorbing the heat (Fig. 17A) and then releasing the heat to the cold sensitive device, thereby maintaining the temperature of the cold sensitive device constant (Fig. 17B);

FIG.18 is a perspective view of a thin film PCEA formulated in accordance with the present disclosure and contacted to a thermally conductive material, only on one side;

FIG. 19 is a perspective view of a thin film PCEA formulated in accordance with the present disclosure and sandwiched between two layers of thermally conductive material;

FIG. 20 is a cross-sectional view taken along a line 3-3' of the thin film PCEA/thermally conductive material in FIG. 18, wherein the heat of the hot spot applied to one end of the PCEA is diffused across the entire surface of the PCEA and thereafter is absorbed by the PCEA's endothermic agent;

FIG. 21 is a cross-sectional view taken along a line 4-4' of the thick film thermally conductive material/PCEA sandwich of FIG. 19, wherein the heat of the hot spots applied to one end of the sandwich is diffused across the entire surface of the PCEA and thereafter is absorbed by the PCEA's endothermic agent.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The inventive thermal control composite i.e. the PCEA material 10 of Fig. 1, Fig. 2, Fig. 3, and Fig. 4 shows the endothermic agent 11 dispersed, distributed and suspended within a polymer or plastic 12.

(a) The polymer or plastic.

The plastic or polymer 12 of the PCEA material 10 may comprise any natural or synthetic polymer or a mixture thereof. Such natural and synthetic polymers comprise: all latexes including those used in paint; fluoropolymers such as various TEFLON® species, specifically polytetrafluoroethylene (PTFE), polyfluoroacetate (PFA) and fluoroethylpropylene(FEP) and other fluorinated plastic films having similar thermal stability, i.e. FEP: -200 DEGREES C TO 200 DEGREES C and PFA: -200 DEGREES C TO 250 DEGREES C, that are well known in the art; expanded TEFLON®; high temperature fluoroelastomers such as VITON® and other highly thermoresistant polymers and plastics well known in the art; elastomers such as SILICONE® species specifically polydimethylsiloxane and polymethylphenylsiloxane and other siloxanes well known in the art; polyimides such as KAPTON®; POLYESTERS® such as MYLAR®; high density polymers such as TIVAR® and SPECTRA®; and other polyamides, polyarylates, polyetherimides, polyketones, polyphenylene oxides or sulfides, polyphenylsulfones, polysulfones, acetals, nylons, ABS, polyetherketones, phenolics, polystyrenes, cellulose, polycarbonates, polyethylenes, polypropylenes, acrylics, polyurethanes, polyvinyls, polyvinylchlorides, BRICKLITE®, polymeric and plastic materials well known to those skilled in the art of plastic materials. Preferably though the carrier plastic or polymer 13 should be TEFLON®, SILICONE®, or VITON®.

These polymers can be photo, thermally or chemically cured. More importantly however, they have a molecular structure consisting of long chains of mostly linear molecules, which after being relaxed by either controlled heating, dissolution or suspension in a plasticizer or solvent, provide the interstitial spaces, through which the endothermic or thermal storage compounds weave and are distributed prior to curing and the final formation of the PCEA.

(b) The endothermic agent.

An endothermic compound or agent is by definition a compound that absorbs heat. The endothermic agents of the present invention can be strict

endotherms, i.e. they absorb and retain heat without releasing it into the surrounding environment. Or they can be recyclable endotherms, such as phase change materials, where they absorb heat initially and then they release the heat, if they are subjected to an environmental temperature differential.

5

The endothermic agents of the present invention comprise the following: oxidized and unoxidized polymers; oxidized and unoxidized homopolymers of ethylene polymer compounds; carbon monoxide-bonded copolymers; micronized polyethylene waxes such as stearic acid; waxes derived from petroleum; ethylene-bis-stearamide; N,N-ethylene-bis-stearamide; various tars; high molecular weight oils and hydrocarbons; polyvinyl alcohols; oxidized and unoxidized polyethylene homopolymers; carnauba wax; aluminum hydroxide, calcium hydroxide, potassium hydroxide, lithium hydroxide and the mixtures thereof; boric acid; dodecaborane, paraldehyde, paraformaldehyde, trioxane and the mixtures thereof; lithium formate, lithium acetate, lithium carbonate, calcium carbonate, silicon carbonate, magnesium carbonate, sodium bicarbonate and the mixtures thereof; salts of acetic acid, salts of formic acid, salts of boric acid and the mixtures thereof; lithium chloride trihydrate, lithium nitrate trihydrate, sodium carbonate decahydrate, sodium borate decahydrate, hydrated epsom salts, magnesium nitrate hexahydrate, beryllium sulfate tetrahydrate, sodium phosphate dodecahydrate, calcium chloride hexahydrate, zinc sulfate heptahydrate, magnesium chloride hexahydrate, sodium sulfate decahydrate, aluminum oxide trihydrate, aluminum sulfate decahydrate, aluminum fluoride trihydrate, and the mixtures thereof; and any eutectic mixtures of any of these materials or families of materials including salts with melting points below 550 degrees Celsius.

These endothermic agents may be micronized and added to the polymer(s) after said polymer(s) have been relaxed by either controlled heating, dissolution or suspension in a plasticizer or solvent. The endothermic agents are then subjected to a mixing process by which they are distributed through and suspended in the polymer(s)' interstitial spaces, or in the interstitial spaces of

the outer surface of the polymer(s), and fixed therein through final curing steps which result in the inventive thermal control composite i.e. the PCEA.

5 The ultimate effective concentration of the endotherm in the PCEA is determined on a case by case application basis by such factors as: the particular application i.e. whether the application requires the absorption of heat or the release of heat, the needed heat capacity of the application, the type of polymer used, the particulate size of the endotherm, and the needed flexibility and use of the novel PCEA. Thus, when seeking a drapeable PCEA having a thickness of 10 0.3 to 1.0 mil for a heat absorbing/heat protective clothing application the carrier plastic or polymer may be a fluoroelastomer, and the concentration of the endothermic agent or thermal storage compound may range from 0.0001 to 1.2 grams of endotherm per square inch of PCEA; with a preferred concentration of 0.01 to 0.06 grams of endotherm per square inch of PCEA.

15 On the other hand, when seeking a flexible PCEA having an observable thickness of, for example 1 inch, then the carrier polymer may be a silicone and the effective concentration of the endotherm in the PCEA will be 0.05%-60% by weight endotherm in PCEA; with a preferred concentration of 20% by 20 weight endotherm in PCEA, for extreme maximum flexibility relative to the highest heat capacity.

25 The heat absorption/heat protective and/or the heat release/heat preservation properties of the present inventive PCEA materials become readily apparent in the Test Examples below, which represent various embodiments of the inventive PCEAs.

(c) Embodiments of the Invention.

30 A series of different PCEAs were prepared in accordance with the principles and requirements as described above. Specifically, natural or synthetic polymers were selected from the group of polymers set forth above. These polymers in turn were softened or liquified by (i) heat, (ii) solution in a

solvent or (iii) suspension in a plasticizer, using conventional methods of softening and liquification already known in the art of polymer handling and processing.

5 To these softened or liquified polymers, in turn, were added an endothermic or a recyclable endothermic agent, preferably micronized, selected from the group of endotherms or thermal storage compounds set forth above, in specific concentrations. The polymer and endotherm combinations were then mixed thoroughly to insure the distribution, dispersal, and suspension of the endotherms in the polymers's interstitial spaces; said spaces being formed during the softening of the polymers' long chains of mostly linear molecules. The mixtures were then molded and cured into PCEA thin and thick films, PCEA bricks, various shaped PCEA mulches or extruded, or extruded and spun into PCEA fibers. Alternatively, the PCEA mixtures were contacted, painted and cured onto a polymer substrate, so that upon cooling, or evaporation of the solvent or the plasticizer, the PCEA is literally adsorbed only on the surface of the underlying polymer substrate.

20 These PCEAS were then tested to determine their heat absorbing capacities and performance, using standard calorimeter testing procedures. The results of some of these PCEA calorimeter tests were as follows:

TEST EXAMPLE I POLYMER/BORIC ACID FILM

25 POLYMER: VITON OR OTHER FLUOROELASTOMER
ENDOTHERMIC AGENT: BORIC ACID I.E. A STRICT ENDOTHERM.
LATENT HEAT OF DECOMPOSITION OF BORIC ACID: 400 CAL/G
THICKNESS OF FILM: 0.001 INCH
30 CONCENTRATION OF BORIC ACID IN THE PCEA: 0.03 GM OF BORIC ACID PER SQUARE INCH OF PCEA.
AMOUNT OF HEAT ABSORBED: 10,368 CAL/SQ.YD; 8 CAL/SQ. IN.

TEST EXAMPLE II
POLYMER/WAX FILM

POLYMER: VITON OR OTHER FLUROELASTOMER
ENDOTHERMIC AGENT: WAX I.E. RECYCLABLE ENDOTHERM
CAPABLE OF ABSORBING HEAT AND THEN RELEASING IT.
LATENT HEAT OF FUSION OF WAX: 30CAL/G
THICKNESS OF FILM: 0.001 INCH
CONCENTRATION OF WAX IN THE PCEA: 0.03 GM OF WAX PER
SQUARE INCH OF PCEA.
AMOUNT OF HEAT ABSORBED:1166.4 CAL/SQ.YD; 0.9 CAL/SQ. IN.

TEST EXAMPLE III
SILICONE/BORIC ACID FILM

POLYMER: SILICON
ENDOTHERMIC AGENT: BORIC ACID I.E. A STRICT ENDOTHERM
LATENT HEAT OF DECOMPOSITION OF BORIC ACID: 400 CAL/G
THICKNESS OF FILM: 0.001 INCH OR 1.0 MIL
CONCENTRATION OF BORIC ACID IN THE PCEA: 0.05 GM OF BORIC
ACID PER SQUARE INCH OF PCEA.
AMOUNT OF HEAT ABSORBED:20 CAL/SQ. IN.

TEST EXAMPLE IV
SILICONE/ENDOTHERM PCEA

POLYMER: SILICONE
ENDOTHERMIC AGENT: HOMOPOLYMER I.E. A RECYCLABLE
ENDOTHERM
LATENT HEAT OF FUSION OF THE HOMOPOLYMER: 80 CAL/GM.
PREPARATION: THE HOMOPOLYMER IS SUSPENDED IN A SILICONE
GEL AND CURED.

RESULTS:

- (A) THE FLEXIBILITY VALUES ARE A DIRECT
FUNCTION OF THE RATIO OF ENDOTHERM
TO SILICONE;
- (B) AT A HOMOPOLYMER CONCENTRATION
OF 10% BY WEIGHT HOMOPOLYMER IN
SILICONE PCEA THE AMOUNT OF HEAT
ABSORBED IS 8 CAL/100 GMS OF PCEA;
- (C) AT A HOMOPOLYMER CONCENTRATION
OF 20% BY WEIGHT HOMOPOLYMER IN
SILICONE PCEA, THE AMOUNT OF HEAT
ABSORBED IS 16 CAL/100 GMS OF PCEA;

- (D) AT A HOMOPOLYMER CONCENTRATION OF 35% BY WEIGHT HOMOPOLYMER IN SILICONE PCEA, THE AMOUNT OF HEAT ABSORBED IS 28 CAL/100 GMS OF PCEA;
- (E) AT A HOMOPOLYMER CONCENTRATION OF 60% BY WEIGHT HOMOPOLYMER IN SILICONE PCEA, THE AMOUNT OF HEAT ABSORBED IS 48 CAL/100 GMS OF PCEA. NOTE THAT THE PCEA IS BRITTLE AND FLAKES I.E. MORE SUITABLE FOR MULCH TYPE APPLICATIONS;

TEST EXAMPLE IV SILICONE/BORIC ACID PCEA

POLYMER: SILICONE

ENDOTHERMIC AGENT: BORIC ACID I.E. A STRICT ENDOTHERM
ENDOTHERM: BORIC ACID HAVING A LATENT HEAT OF FUSION OF 400 CAL/GM AT 140 DEGREES CELSIUS.

PREPARATION: THE BORIC ACID IS SUSPENDED IN A SILICONE GEL AND CURED.

RESULTS:

- (A) THE FLEXIBILITY VALUES ARE A DIRECT FUNCTION OF THE RATIO OF ENDOTHERM TO SILICONE;
- (B) AT A BORIC ACID CONCENTRATION OF 20% BY WEIGHT BORIC ACID IN SILICONE PCEA THE AMOUNT OF HEAT ABSORBED IS 80 CAL/100 GMS OF PCEA.

TEST EXAMPLE V FLUOROCARBON/CARBON MONOXIDE COPOLYMER FILM

POLYMER: FLUOROCARBON

ENDOTHERMIC AGENT: CARBON MONOXIDE COPOLYMER I.E. A RECYCLABLE ENDOTHERM

LATENT HEAT OF FUSION OF CARBON MONOXIDE COPOLYMER: 103 CAL/G

THICKNESS OF FILM: 0.001 INCH

CONCENTRATION OF CARBON MONOXIDE COPOLYMER IN THE PCEA: 0.06 GM PER SQUARE INCH OF PCEA.

AMOUNT OF HEAT ABSORBED: 6.2 CAL/SQ. IN.

NOTE: Carbon monoxide copolymer is a recyclable endotherm. This means that after it has absorbed 6.2 cal/sq.in. the PCEA can be used to transfer 6.2 cal/sq.in. to a cold sensitive device, animal, or human, which is being exposed to extreme cold conditions.

TEST EXAMPLE VI FLUOROCARBON/HOMOPOLYMER FILM

POLYMER: FLUOROCARBON
LATENT HEAT OF FUSION OF HOMOPOLYMER: 80 CAL/G
THICKNESS OF FILM: 0.001 INCH
CONCENTRATION OF HOMOPOLYMER IN THE PCEA: 0.06 GM PER SQUARE INCH OF PCEA.
AMOUNT OF HEAT ABSORBED: 4.8 CAL/SQ. IN.

NOTE: The Homopolymer is a recyclable endotherm. This means that after it has absorbed 4.8 cal/sq. in. the PCEA can be used to transfer 4.8 cal/sq. in. to a cold sensitive device, animal, or human, which is being exposed to extreme cold conditions.

TEST EXAMPLE VII SILICONE/HOMOPOLYMER:CARBON MONOXIDE COPOLYMER PCEA

POLYMER: SILICONE
ENDOTHERMIC AGENTS: HOMOPOLYMER AND CARBON MONOXIDE COPOLYMER I.E. RECYCLABLE ENDOTHERMS
LATENT HEAT OF FUSION OF THE HOMOPOLYMER IS 80 CAL/GM; CARBON MONOXIDE COPOLYMER HAVING 103 CAL/GM; 50:50 RATIO HAS A LATENT HEAT OF FUSION OF 91.5 CAL/GM.

PREPARATION: THE HOMOPOLYMER AND CARBON MONOXIDE COPOLYMER ARE SUSPENDED IN A SILICONE GEL AND CURED.

RESULTS:

- (A) THE FLEXIBILITY VALUES ARE A DIRECT FUNCTION OF THE RATIO OF ENDOTHERMS TO SILICONE;
- (B) AT ENDOTHERM CONCENTRATION OF 20% BY WEIGHT THE AMOUNT OF HEAT ABSORBED AND CAPABLE OF BEING RELEASED IS 1830 CAL/100 GMS OF PCEA.

It is clear from the above that PCEAs will perform superbly in applications directed to the absorption of heat. Furthermore, when the applications call for near isothermal conditions, i.e. two dimensional thermal conductivity or increased thermal conductivity along the surface plane, then any PCEA set forth in the examples above, or formed in accordance with the present disclosure, can be coupled with a metalized or thermally conductive material. This will diffuse the heat of hot spots across the entire surface of the PCEA. In fact, it was found that when a thermally conductive material was contacted to a 1.0 mil thick PCEA film comprising a homopolymer endotherm whose concentration was 0.02 gm of homopolymer endotherm per sq. in., the homopolymer (heat of fusion: 80 cal/gm) was capable of rapidly absorbing 2073.6 cal over 1 sq. yard; regardless of where the thermal flux was applied on the surface of the PCEA.

When the PCEA applications require some kind of ventilation and breathability, as for example in clothing, then the PCEA film can be pierced or provided with tears, holes, or openings. Such openings do not compromise the heat absorption performance of the PCEAs, nor do they affect the overall structural integrity of the application.

(d) Invention Applications.

The inventive PCEAs can be formed into thin and thick films. They may be drawn, molded or spun into fibers of all dimensions. They can be formed and chopped into PCEA mulch; the size of the mulch varying with the particular application. They can be molded into a brick or gasket. In fact, various modifications can be made to the present invention, as will be apparent to those skilled in the art; modifications which will depend on and become readily apparent from the particular applications for which the inventive PCEAs are intended for.

Thus, depending on the characteristics of the PCEA prepared, i.e. the heat capacity of its endothermic agent(s), the polymer(s) used, its form size and

shape, the PCEA can be used for thermal control in protective clothing, winter clothing, boats, furniture, pipes, diving suits, hoses, auto interiors, fire walls, chemical processes, kitchen clothing and gear. Or, the PCEA can be used for environmental control in paint, pipes, tubs, walls as shown for example in Fig. 12, shipping containers, medical devices, food, homes, aircraft, automobiles and tanks. Finally the inventive PCEAs can be used as protective pads in gloves, shoes, lab coats, fire gear and even ablative surgery; while, recyclable PCEAs, which are endotherms that make use of their latent heats of fusion, are ideal in use for dive suits and warm weather clothing, tents and gear.

In fact, the applications and uses of the inventive PCEA are infinite; limited only by the imagination of man and his ability to design new ways to protect in extreme environmental conditions, either hot or cold. Thus, the PCEA can also be formed into surfaces for use under carpets or adhered to carpets using a method such as that portrayed in Fig. 10 and Fig. 11 in an effort to keep homes in as near an isothermal situation as possible. On the other hand, the PCEA may also be used as a means of camouflage by the removal of the heat signature of military combat gear, troops and military vehicles; or as a flexible thermal shield for the protection of spacecraft electronics and satellites from the harmful effects of solar radiation. Finally, PCEA fibers can be knit, spun or woven into protective cloth as shown in Fig. 8 and Fig. 9, whose applications can also be infinite.

Accordingly, while only a few embodiments of the present invention have been shown and described, it is to be understood that many changes and modifications may be made thereunto without departing from the spirit and scope of the invention as disclosed herein.

The invention claimed is:

1. A flexible thermal control composite comprising an endothermic agent and a polymer, wherein said endothermic agent is distributed, dispersed and suspended within said polymer.

2. The flexible thermal control composite of claim 1, further comprising a thermally conductive material contacted to said flexible thermal control composite.

3. The flexible thermal control composite of claim 1, wherein the endothermic agent is recyclable.

4. The flexible thermal control composite of claim 2, wherein the endothermic agent is recyclable.

5. The flexible thermal control composite of claim 1, wherein the endothermic agent is micronized.

6. The flexible thermal control composite of claim 2, wherein the endothermic agent is micronized.

7. The flexible thermal control composite of claim 3, wherein the recyclable endothermic agent is micronized.

8. The flexible thermal control composite of claim 4, wherein the recyclable endothermic agent is micronized.

20 9. The flexible thermal control composite of claim 1, wherein said endothermic agent is selected from the group consisting of oxidized polymers, unoxidized polymers, oxidized homopolymers, unoxidized homopolymers of ethylene polymer compounds, carbon monoxide-bonded copolymers, micronized polyethylene waxes, petroleum derived waxes, ethylene-bis-stearamide, N,N-ethylene-bis-stearamide, tars, high molecular weight oils, high molecular weight hydrocarbons, polyvinyl alcohols, oxidized polyethylene homopolymers, unoxidized polyethylene homopolymers, carnauba wax, aluminum hydroxide, calcium hydroxide, potassium hydroxide, lithium hydroxide, boric acid, paraldehyde, paraformaldehyde, trioxane, lithium formate, lithium acetate, lithium carbonate, calcium carbonate, silicon carbonate, magnesium carbonate, sodium bicarbonate, salts of acetic acid, salts of formic acid, salts of boric acid, lithium chloride trihydrate, lithium nitrate trihydrate, sodium carbonate decahydrate, sodium borate decahydrate, hydrated epsom salts, magnesium nitrate hexahydrate, beryllium sulfate tetrahydrate, sodium phosphate dodecahydrate, calcium chloride hexahydrate, zinc sulfate heptahydrate, magnesium chloride hexahydrate, sodium sulfate decahydrate, aluminum oxide trihydrate, aluminum sulfate decahydrate, aluminum fluoride trihydrate, aluminum nitrate nonhydrate and any eutectic blends of any of these materials or families of materials including salts with melting points below 550 degrees Celsius.

10. The flexible thermal control composite of claim 2, wherein said
40 endothermic agent is selected from the group consisting of oxidized polymers,
unoxidized polymers, oxidized homopolymers, unoxidized homopolymers of
ethylene polymer compounds, carbon monoxide-bonded copolymers, micronized
polyethylene waxes, petroleum derived waxes, ethylene-bis-stearamide, N,N-
ethylene-bis-stearamide, tars, high molecular weight oils, high molecular weight
45 hydrocarbons, polyvinyl alcohols, oxidized polyethylene homopolymers, unoxidized
polyethylene homopolymers, carnauba wax, aluminum hydroxide, calcium
hydroxide, potassium hydroxide, lithium hydroxide, boric acid, paraldehyde,
paraformaldehyde, trioxane, lithium formate, lithium acetate, lithium carbonate,
calcium carbonate, silicon carbonate, magnesium carbonate, sodium bicarbonate,
50 salts of acetic acid, salts of formic acid, salts of boric acid, lithium chloride
trihydrate, lithium nitrate trihydrate, sodium carbonate decahydrate, sodium borate
decahydrate, hydrated epsom salts, magnesium nitrate hexahydrate, beryllium
sulfate tetrahydrate, sodium phosphate dodecahydrate, calcium chloride
hexahydrate, zinc sulfate heptahydrate, magnesium chloride hexahydrate, sodium
55 sulfate decahydrate, aluminum oxide trihydrate, aluminum sulfate decahydrate,
aluminum fluoride trihydrate, aluminum nitrate nonhydrate and any eutectic blends
of any of these materials or families of materials including salts with melting points
below 550 degrees Celsius.

11. The flexible thermal control composite of claim 5, wherein said
60 micronized endothermic agent is selected from the group consisting of micronized
oxidized polymers, unoxidized polymers, oxidized homopolymers, unoxidized

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homopolymers of ethylene polymer compounds, carbon monoxide-bonded copolymers, micronized polyethylene waxes, petroleum derived waxes, ethylene-bis-stearamide, N,N-ethylene-bis-stearamide, tars, high molecular weight oils, high molecular weight hydrocarbons, polyvinyl alcohols, oxidized polyethylene homopolymers, unoxidized polyethylene homopolymers, carnauba wax, aluminum hydroxide, calcium hydroxide, potassium hydroxide, lithium hydroxide, boric acid, paraldehyde, paraformaldehyde, trioxane, lithium formate, lithium acetate, lithium carbonate, calcium carbonate, silicon carbonate, magnesium carbonate, sodium bicarbonate, salts of acetic acid, salts of formic acid, salts of boric acid, lithium chloride trihydrate, lithium nitrate trihydrate, sodium carbonate decahydrate, sodium borate decahydrate, hydrated epsom salts, magnesium nitrate hexahydrate, beryllium sulfate tetrahydrate, sodium phosphate dodecahydrate, calcium chloride hexahydrate, zinc sulfate heptahydrate, magnesium chloride hexahydrate, sodium sulfate decahydrate, aluminum oxide trihydrate, aluminum sulfate decahydrate, aluminum fluoride trihydrate, aluminum nitrate nonhydrate and any eutectic blends of any of these materials or families of materials including salts with melting points below 550 degrees Celsius.

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12. The flexible thermal control composite of claim 6, wherein said micronized endothermic agent is selected from the group consisting of micronized oxidized polymers, unoxidized polymers, oxidized homopolymers, unoxidized homopolymers of ethylene polymer compounds, carbon monoxide-bonded copolymers, micronized polyethylene waxes, petroleum derived waxes, ethylene-bis-stearamide, N,N-ethylene-bis-stearamide, tars, high molecular weight oils, high

85 molecular weight hydrocarbons, polyvinyl alcohols, oxidized polyethylene
homopolymers, unoxidized polyethylene homopolymers, carnauba wax, aluminum
hydroxide, calcium hydroxide, potassium hydroxide, lithium hydroxide, boric acid,
paraldehyde, paraformaldehyde, trioxane, lithium formate, lithium acetate, lithium
90 bicarbonate, salts of acetic acid, salts of formic acid, salts of boric acid, lithium
chloride trihydrate, lithium nitrate trihydrate, sodium carbonate decahydrate,
sodium borate decahydrate, hydrated epsom salts, magnesium nitrate hexahydrate,
beryllium sulfate tetrahydrate, sodium phosphate dodecahydrate, calcium chloride
hexahydrate, zinc sulfate heptahydrate, magnesium chloride hexahydrate, sodium
95 sulfate decahydrate, aluminum oxide trihydrate, aluminum sulfate decahydrate,
aluminum fluoride trihydrate, aluminum nitrate nonhydrate and any eutectic blends
of any of these materials or families of materials including salts with melting points
below 550 degrees Celsius.

13. The thermal control composite of claim 3, wherein said
100 recyclable endothermic agent is selected from the group consisting of oxidized
polymers, unoxidized polymers, oxidized homopolymers, unoxidized
homopolymers of ethylene polymer compounds, carbon monoxide-bonded
copolymers, micronized polyethylene waxes, petroleum derived waxes, ethylene-
bis-stearamide, N,N-ethylene-bis-stearamide, tars, high molecular weight oils, high
105 molecular weight hydrocarbons, polyvinyl alcohols, oxidized polyethylene
homopolymers, unoxidized polyethylene homopolymers, carnauba wax, glycerin,
glycol, and glycerin/glycol hydrated salts and any eutectic blends of any of these

materials or families of materials including salts with melting points below 550 degrees Celsius.

110 14. The thermal control composite of claim 4, wherein said
recyclable endothermic agent is selected from the group consisting of oxidized
polymers, unoxidized polymers, oxidized homopolymers, unoxidized
homopolymers of ethylene polymer compounds, carbon monoxide-bonded
115 copolymers, micronized polyethylene waxes, petroleum derived waxes, ethylene-
bis-stearamide, N,N-ethylene-bis-stearamide, tars, high molecular weight oils, high
molecular weight hydrocarbons, polyvinyl alcohols, oxidized polyethylene
homopolymers, unoxidized polyethylene homopolymers, carnauba wax, glycerin,
glycol, and glycerin/glycol hydrated salts and any eutectic blends of any of these
120 materials or families of materials including salts with melting points below 550
degrees Celsius.

125 15. The thermal control composite of claim 7, wherein said
recyclable, micronized, endothermic agent is selected from the group consisting of
oxidized polymers, unoxidized polymers, oxidized homopolymers, unoxidized
homopolymers of ethylene polymer compounds, carbon monoxide-bonded
copolymers, micronized polyethylene waxes, petroleum derived waxes, ethylene-
bis-stearamide, N,N-ethylene-bis-stearamide, tars, high molecular weight oils, high
molecular weight hydrocarbons, polyvinyl alcohols, oxidized polyethylene
homopolymers, unoxidized polyethylene homopolymers, carnauba wax, glycerin,
glycol, and glycerin/glycol hydrated salts and any eutectic blends of any of these

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materials or families of materials including salts with melting points below 550 degrees Celsius.

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16. The thermal control composite of claim 8, wherein said recyclable, micronized endothermic agent is selected from the group consisting of oxidized polymers, unoxidized polymers, oxidized homopolymers, unoxidized homopolymers of ethylene polymer compounds, carbon monoxide-bonded copolymers, micronized polyethylene waxes, petroleum derived waxes, ethylene-bis-stearamide, N,N-ethylene-bis-stearamide, tars, high molecular weight oils, high molecular weight hydrocarbons, polyvinyl alcohols, oxidized polyethylene homopolymers, unoxidized polyethylene homopolymers, carnauba wax, glycerin, glycol, and glycerin/glycol hydrated salts and any eutectic blends of any of these materials or families of materials including salts with melting points below 550 degrees Celsius.

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17. The thermal control composite of claim 3, wherein said recyclable endothermic agent is a phase change material.

18. The thermal control composite of claim 4, wherein said recyclable endothermic agent is a phase change material.

19. The thermal control composite of claim 7, wherein said recyclable, micronized, endothermic agent is a phase change material.

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20. The thermal control composite of claim 8, wherein said recyclable, micronized endothermic agent is a phase change material.

21. The flexible thermal control composite of claim 1, wherein said polymer is selected from the group of polymers consisting of natural and synthetic polymers.

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22. The flexible thermal control composite of claim 2, wherein said polymer is selected from the group of polymers consisting of natural and synthetic polymers.

23. The flexible thermal control composite of claim 3, wherein said polymer is selected from the group of polymers consisting of natural and synthetic polymers.

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24. The flexible thermal control composite of claim 4, wherein said polymer is selected from the group of polymers consisting of natural and synthetic polymers.

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25. The flexible thermal control composite of claim 5, wherein said polymer is selected from the group of polymers consisting of natural and synthetic polymers.

26. The flexible thermal control composite of claim 6, wherein said polymer is selected from the group of polymers consisting of natural and synthetic polymers.

27. The flexible thermal control composite of claim 7, wherein said polymer is selected from the group of polymers consisting of natural and synthetic polymers.

28. The flexible thermal control composite of claim 8, wherein said polymer is selected from the group of polymers consisting of natural and synthetic polymers.

29. The flexible thermal control composite of claim 9, wherein said polymer is selected from the group of polymers consisting of natural and synthetic polymers.

30. The flexible thermal control composite of claim 10, wherein said polymer is selected from the group of polymers consisting of natural and synthetic polymers.

31. The flexible thermal control composite of claim 11, wherein said polymer is selected from the group of polymers consisting of natural and synthetic polymers.

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32. The flexible thermal control composite of claim 12, wherein said polymer is selected from the group of polymers consisting of natural and synthetic polymers.

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33. The flexible thermal control composite of claim 13, wherein said polymer is selected from the group of polymers consisting of natural and synthetic polymers.

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34. The flexible thermal control composite of claim 14, wherein said polymer is selected from the group of polymers consisting of natural and synthetic polymers.

35. The flexible thermal control composite of claim 15, wherein said polymer is selected from the group of polymers consisting of natural and synthetic polymers.

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36. The flexible thermal control composite of claim 16, wherein said polymer is selected from the group of polymers consisting of natural and synthetic polymers.

37. The flexible thermal control composite of claim 17, wherein said polymer is selected from the group of polymers consisting of natural and synthetic polymers.

38. The flexible thermal control composite of claim 18, wherein said polymer is selected from the group of polymers consisting of natural and synthetic polymers.

205 39. The flexible thermal control composite of claim 19, wherein said polymer is selected from the group of polymers consisting of natural and synthetic polymers.

210 40. The flexible thermal control composite of claim 20, wherein said polymer is selected from the group of polymers consisting of natural and synthetic polymers.

41. The flexible thermal control composite of claim 1, wherein said polymer is selected from the group of polymers consisting of latexes, fluoropolymers, expanded fluoropolymers, fluoroelastomers, elastomers polyimides, polyesters, high density polymers, polyamides, polyarylates, polyetherimides, polyketones, polyphenylene oxides, polyphenylene sulfides, polyphenylsulfones, polysulfones, acetals, nylons, ABS, polyetheretherketones, phenolics, polystyrenes, polycarbonates, polyethylenes, polypropylenes, acrylics, polyurethanes, polyvinyls, polyvinylchlorides, polymeric, plastic materials well known to those skilled in the art of thermoprotective materials and the mixtures thereof.

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42. The flexible thermal control composite of claim 2, wherein said polymer is selected from the group of polymers consisting of latexes, fluoropolymers, expanded fluoropolymers, fluoroelastomers, elastomers polyimides, polyesters, high density polymers, polyamides, polyarylates, polyetherimides, polyketones, polyphenylene oxides, polyphenylene sulfides, polyphenylsulfones, polysulfones, acetals, nylons, ABS, polyetheretherketones, phenolics, polystyrenes, polycarbonates, polyethylenes, polypropylenes, acrylics, polyurethanes, polyvinyls, polyvinylchlorides, polymeric, plastic materials well known to those skilled in the art of thermoprotective materials and the mixtures thereof.

43. The flexible thermal control composite of claim 3, wherein said polymer is selected from the group of polymers consisting of latexes, fluoropolymers, expanded fluoropolymers, fluoroelastomers, elastomers polyimides, polyesters, high density polymers, polyamides, polyarylates, polyetherimides, polyketones, polyphenylene oxides, polyphenylene sulfides, polyphenylsulfones, polysulfones, acetals, nylons, ABS, polyetheretherketones, phenolics, polystyrenes, polycarbonates, polyethylenes, polypropylenes, acrylics, polyurethanes, polyvinyls, polyvinylchlorides, polymeric, plastic materials well known to those skilled in the art of thermoprotective materials and the mixtures thereof.

44. The flexible thermal control composite of claim 4, wherein said polymer is selected from the group of polymers consisting of latexes,

245 fluoropolymers, expanded fluoropolymers, fluoroelastomers, elastomers
polyimides, polyesters, high density polymers, polyamides, polyarylates,
polyetherimides, polyketones, polyphenylene oxides, polyphenylene sulfides,
polyphenylsulfones, polysulfones, acetals, nylons, ABS, polyetheretherketones,
phenolics, polystyrenes, polycarbonates, polyethylenes, polypropylenes, acrylics,
polyurethanes, polyvinyls, polyvinylchlorides, polymeric, plastic materials well
known to those skilled in the art of thermoprotective materials and the mixtures
250 thereof.

255 45. The flexible thermal control composite of claim 5, wherein
said polymer is selected from the group of polymers consisting of latexes,
fluoropolymers, expanded fluoropolymers, fluoroelastomers, elastomers
polyimides, polyesters, high density polymers, polyamides, polyarylates,
polyetherimides, polyketones, polyphenylene oxides, polyphenylene sulfides,
polyphenylsulfones, polysulfones, acetals, nylons, ABS, polyetheretherketones,
phenolics, polystyrenes, polycarbonates, polyethylenes, polypropylenes, acrylics,
polyurethanes, polyvinyls, polyvinylchlorides, polymeric, plastic materials well
known to those skilled in the art of thermoprotective materials and the mixtures
260 thereof.

46. The flexible thermal control composite of claim 6, wherein
said polymer is selected from the group of polymers consisting of latexes,
fluoropolymers, expanded fluoropolymers, fluoroelastomers, elastomers
polyimides, polyesters, high density polymers, polyamides, polyarylates,

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polyetherimides, polyketones, polyphenylene oxides, polyphenylene sulfides, polyphenylsulfones, polysulfones, acetals, nylons, ABS, polyetheretherketones, phenolics, polystyrenes, polycarbonates, polyethylenes, polypropylenes, acrylics, polyurethanes, polyvinyls, polyvinylchlorides, polymeric, plastic materials well known to those skilled in the art of thermoprotective materials and the mixtures thereof.

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47. The flexible thermal control composite of claim 7, wherein said polymer is selected from the group of polymers consisting of latexes, fluoropolymers, expanded fluoropolymers, fluoroelastomers, elastomers polyimides, polyesters, high density polymers, polyamides, polyarylates, polyetherimides, polyketones, polyphenylene oxides, polyphenylene sulfides, polyphenylsulfones, polysulfones, acetals, nylons, ABS, polyetheretherketones, phenolics, polystyrenes, polycarbonates, polyethylenes, polypropylenes, acrylics, polyurethanes, polyvinyls, polyvinylchlorides, polymeric, plastic materials well known to those skilled in the art of thermoprotective materials and the mixtures thereof.

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48. The flexible thermal control composite of claim 8, wherein said polymer is selected from the group of polymers consisting of latexes, fluoropolymers, expanded fluoropolymers, fluoroelastomers, elastomers polyimides, polyesters, high density polymers, polyamides, polyarylates, polyetherimides, polyketones, polyphenylene oxides, polyphenylene sulfides, polyphenylsulfones, polysulfones, acetals, nylons, ABS, polyetheretherketones,

phenolics, polystyrenes, polycarbonates, polyethylenes, polypropylenes, acrylics, polyurethanes, polyvinyls, polyvinylchlorides, polymeric, plastic materials well known to those skilled in the art of thermoprotective materials and the mixtures thereof.

49. The flexible thermal control composite of claim 10, wherein said polymer is selected from the group of polymers consisting of latexes, fluoropolymers, expanded fluoropolymers, fluoroelastomers, elastomers polyimides, polyesters, high density polymers, polyamides, polyarylates, polyetherimides, polyketones, polyphenylene oxides, polyphenylene sulfides, polyphenylsulfones, polysulfones, acetals, nylons, ABS, polyetheretherketones, phenolics, polystyrenes, polycarbonates, polyethylenes, polypropylenes, acrylics, polyurethanes, polyvinyls, polyvinylchlorides, polymeric, plastic materials well known to those skilled in the art of thermoprotective materials and the mixtures thereof.

50. The flexible thermal control composite of claim 11, wherein said polymer is selected from the group of polymers consisting of latexes, fluoropolymers, expanded fluoropolymers, fluoroelastomers, elastomers polyimides, polyesters, high density polymers, polyamides, polyarylates, polyetherimides, polyketones, polyphenylene oxides, polyphenylene sulfides, polyphenylsulfones, polysulfones, acetals, nylons, ABS, polyetheretherketones, phenolics, polystyrenes, polycarbonates, polyethylenes, polypropylenes, acrylics, polyurethanes, polyvinyls, polyvinylchlorides, polymeric, plastic materials well

known to those skilled in the art of thermoprotective materials and the mixtures thereof.

51. The flexible thermal control composite of claim 12, wherein said polymer is selected from the group of polymers consisting of latexes, fluoropolymers, expanded fluoropolymers, fluoroelastomers, elastomers polyimides, polyesters, high density polymers, polyamides, polyarylates, polyetherimides, polyketones, polyphenylene oxides, polyphenylene sulfides, polyphenylsulfones, polysulfones, acetals, nylons, ABS, polyetheretherketones, phenolics, polystyrenes, polycarbonates, polyethylenes, polypropylenes, acrylics, polyurethanes, polyvinyls, polyvinylchlorides, polymeric, plastic materials well known to those skilled in the art of thermoprotective materials and the mixtures thereof.

52. The flexible thermal control composite of claim 13, wherein said polymer is selected from the group of polymers consisting of latexes, fluoropolymers, expanded fluoropolymers, fluoroelastomers, elastomers polyimides, polyesters, high density polymers, polyamides, polyarylates, polyetherimides, polyketones, polyphenylene oxides, polyphenylene sulfides, polyphenylsulfones, polysulfones, acetals, nylons, ABS, polyetheretherketones, phenolics, polystyrenes, polycarbonates, polyethylenes, polypropylenes, acrylics, polyurethanes, polyvinyls, polyvinylchlorides, polymeric, plastic materials well known to those skilled in the art of thermoprotective materials and the mixtures thereof.

53. The flexible thermal control composite of claim 14, wherein said polymer is selected from the group of polymers consisting of latexes, fluoropolymers, expanded fluoropolymers, fluoroelastomers, elastomers polyimides, polyesters, high density polymers, polyamides, polyarylates, polyetherimides, polyketones, polyphenylene oxides, polyphenylene sulfides, polyphenylsulfones, polysulfones, acetals, nylons, ABS, polyetheretherketones, phenolics, polystyrenes, polycarbonates, polyethylenes, polypropylenes, acrylics, polyurethanes, polyvinyls, polyvinylchlorides, polymeric, plastic materials well known to those skilled in the art of thermoprotective materials and the mixtures thereof.

54. The flexible thermal control composite of claim 15, wherein said polymer is selected from the group of polymers consisting of latexes, fluoropolymers, expanded fluoropolymers, fluoroelastomers, elastomers polyimides, polyesters, high density polymers, polyamides, polyarylates, polyetherimides, polyketones, polyphenylene oxides, polyphenylene sulfides, polyphenylsulfones, polysulfones, acetals, nylons, ABS, polyetheretherketones, phenolics, polystyrenes, polycarbonates, polyethylenes, polypropylenes, acrylics, polyurethanes, polyvinyls, polyvinylchlorides, polymeric, plastic materials well known to those skilled in the art of thermoprotective materials and the mixtures thereof.

55. The flexible thermal control composite of claim 16, wherein said polymer is selected from the group of polymers consisting of latexes,

fluoropolymers, expanded fluoropolymers, fluoroelastomers, elastomers
polyimides, polyesters, high density polymers, polyamides, polyarylates,
polyetherimides, polyketones, polyphenylene oxides, polyphenylene sulfides,
polyphenylsulfones, polysulfones, acetals, nylons, ABS, polyetheretherketones,
phenolics, polystyrenes, polycarbonates, polyethylenes, polypropylenes, acrylics,
polyurethanes, polyvinyls, polyvinylchlorides, polymeric, plastic materials well
known to those skilled in the art of thermoprotective materials and the mixtures
thereof.

56. The flexible thermal control composite of claim 17, wherein
said polymer is selected from the group of polymers consisting of latexes,
fluoropolymers, expanded fluoropolymers, fluoroelastomers, elastomers
polyimides, polyesters, high density polymers, polyamides, polyarylates,
polyetherimides, polyketones, polyphenylene oxides, polyphenylene sulfides,
polyphenylsulfones, polysulfones, acetals, nylons, ABS, polyetheretherketones,
phenolics, polystyrenes, polycarbonates, polyethylenes, polypropylenes, acrylics,
polyurethanes, polyvinyls, polyvinylchlorides, polymeric, plastic materials well
known to those skilled in the art of thermoprotective materials and the mixtures
thereof.

57. The flexible thermal control composite of claim 18, wherein
said polymer is selected from the group of polymers consisting of latexes,
fluoropolymers, expanded fluoropolymers, fluoroelastomers, elastomers
polyimides, polyesters, high density polymers, polyamides, polyarylates,

375 polyetherimides, polyketones, polyphenylene oxides, polyphenylene sulfides,
polyphenylsulfones, polysulfones, acetals, nylons, ABS, polyetheretherketones,
phenolics, polystyrenes, polycarbonates, polyethylenes, polypropylenes, acrylics,
polyurethanes, polyvinyls, polyvinylchlorides, polymeric, plastic materials well
known to those skilled in the art of thermoprotective materials and the mixtures
380 thereof.

58. The flexible thermal control composite of claim 19, wherein
said polymer is selected from the group of polymers consisting of latexes,
fluoropolymers, expanded fluoropolymers, fluoroelastomers, elastomers
polyimides, polyesters, high density polymers, polyamides, polyarylates,
385 polyetherimides, polyketones, polyphenylene oxides, polyphenylene sulfides,
polyphenylsulfones, polysulfones, acetals, nylons, ABS, polyetheretherketones,
phenolics, polystyrenes, polycarbonates, polyethylenes, polypropylenes, acrylics,
polyurethanes, polyvinyls, polyvinylchlorides, polymeric, plastic materials well
known to those skilled in the art of thermoprotective materials and the mixtures
thereof.
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59. The flexible thermal control composite of claim 20, wherein
said polymer is selected from the group of polymers consisting of latexes,
fluoropolymers, expanded fluoropolymers, fluoroelastomers, elastomers
polyimides, polyesters, high density polymers, polyamides, polyarylates,
395 polyetherimides, polyketones, polyphenylene oxides, polyphenylene sulfides,
polyphenylsulfones, polysulfones, acetals, nylons, ABS, polyetheretherketones,
phenolics, polystyrenes, polycarbonates, polyethylenes, polypropylenes, acrylics,

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polyurethanes, polyvinyls, polyvinylchlorides, polymeric, plastic materials well known to those skilled in the art of thermoprotective materials and the mixtures thereof.

ABSTRACT OF THE DISCLOSURE

A flexible thermal control composite comprising a natural or synthetic polymer and an endotherm dispersed, distributed and suspended within said natural or synthetic polymer i.e. "P"olymer "C"ontaining an "E"ndothermic "A"gent (PCEA). The PCEA can be formed into thin and thick films. It can be drawn, molded, extruded and spun into fibers or all dimensions. It can be formed and chopped into PCEA mulch. Irrespective its final form, the PCEA can be used in insulating, thermoprotecting, heat absorbing applications on the one hand, and heat maintenance applications of all types on the other.

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FIG. 1

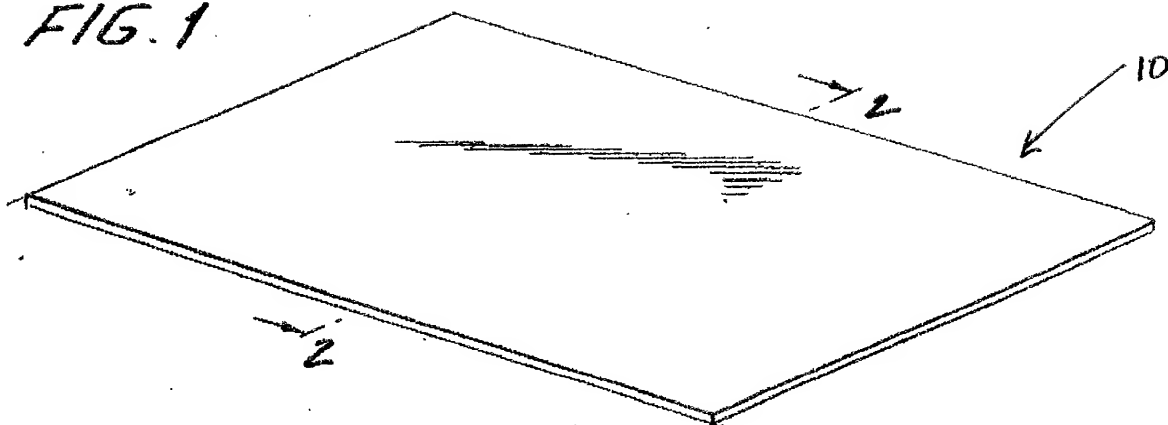


FIG. 2

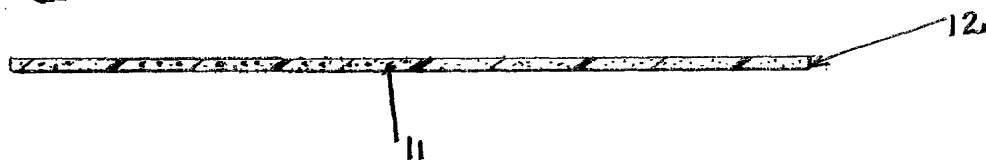


FIG. 3

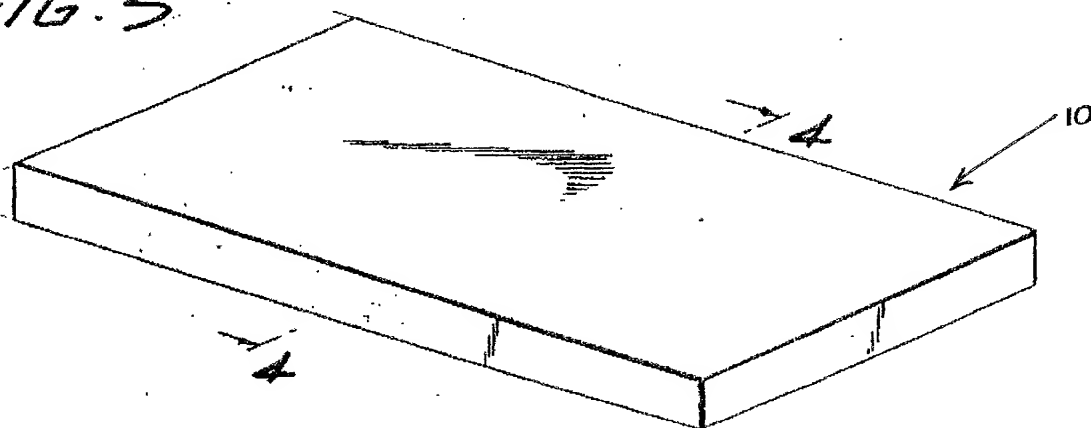
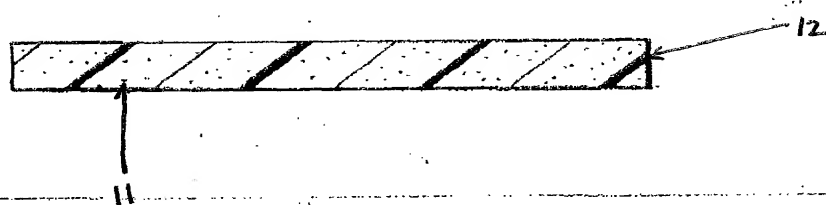


FIG. 4



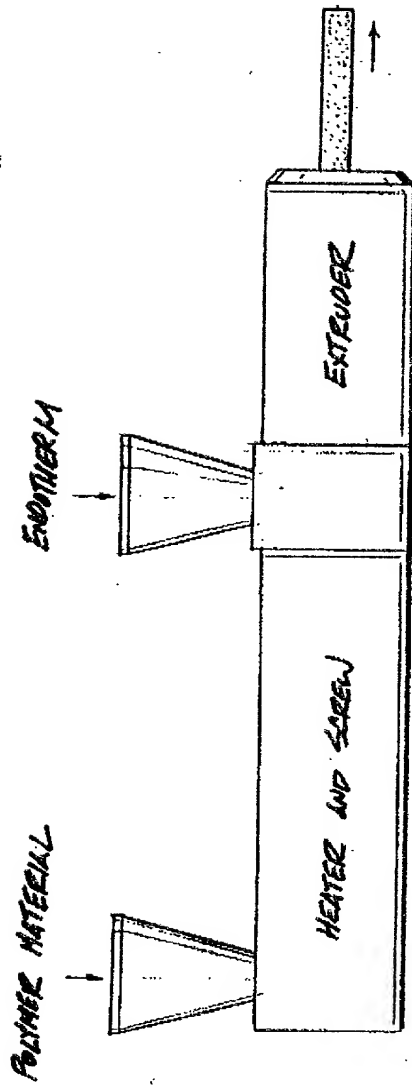


FIG. 5

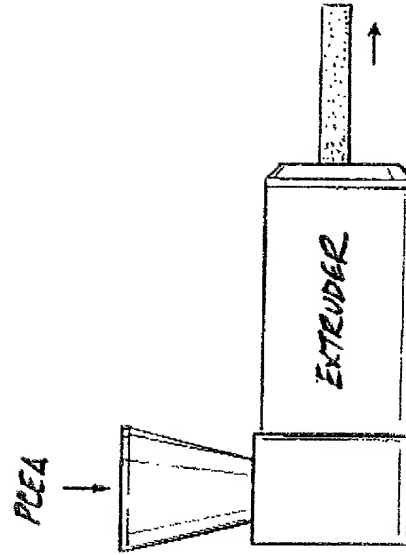


FIG. 6

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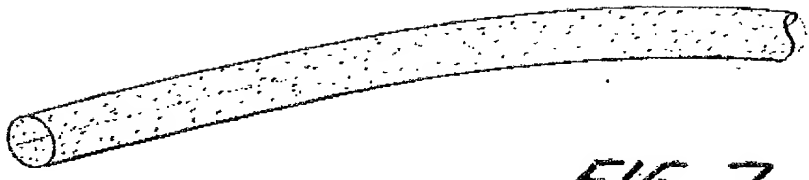


FIG. 7

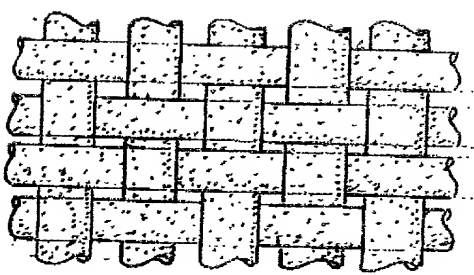


FIG. 8

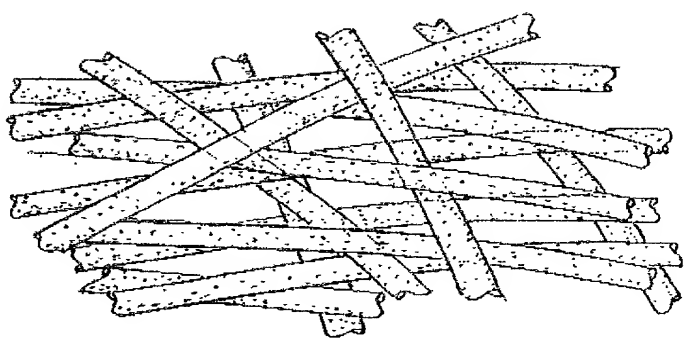


FIG. 9

00615507 074300

006720 20551980

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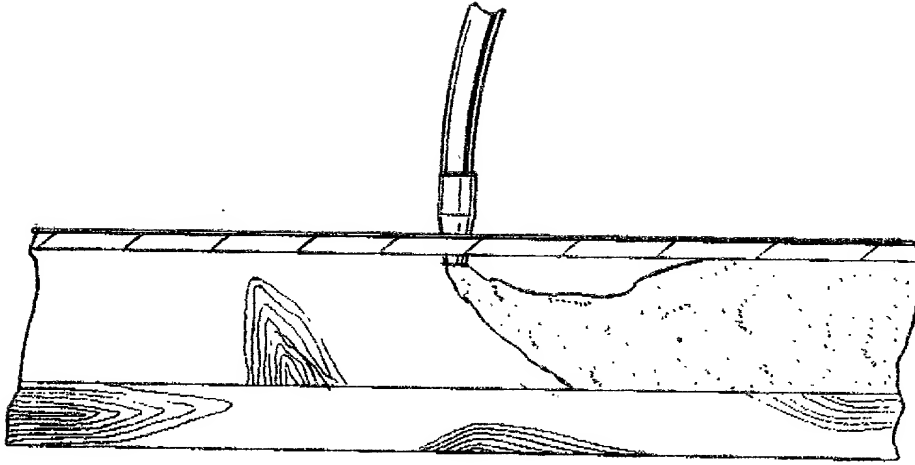


FIG. 12

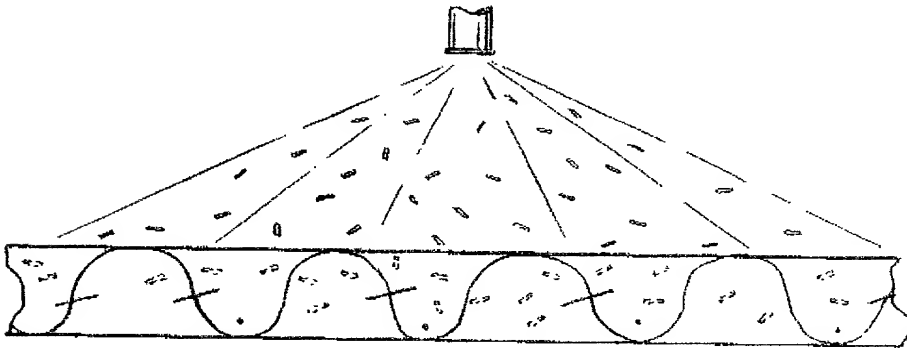


FIG. 11

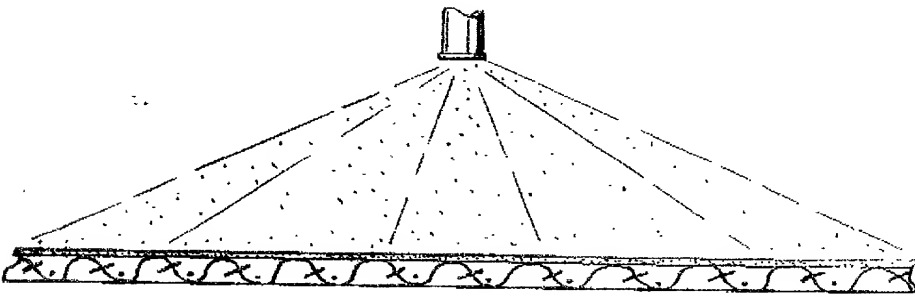


FIG. 10

00615507 074300

FIG. 13

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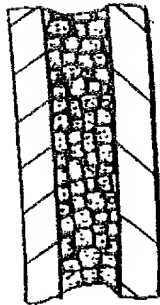
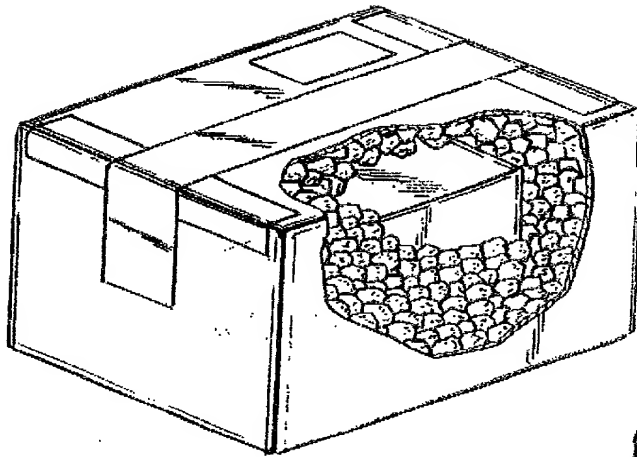


FIG. 15



FIG. 14

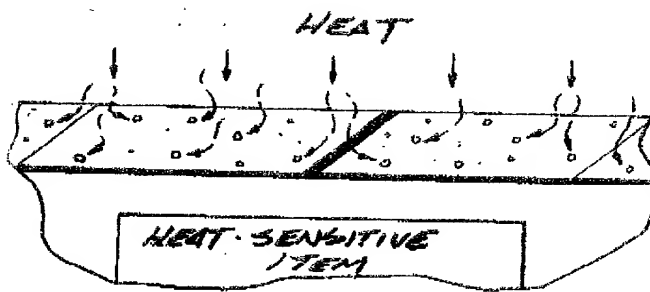


FIG. 16

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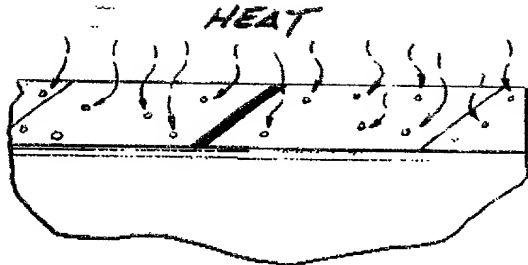


FIG. 17a

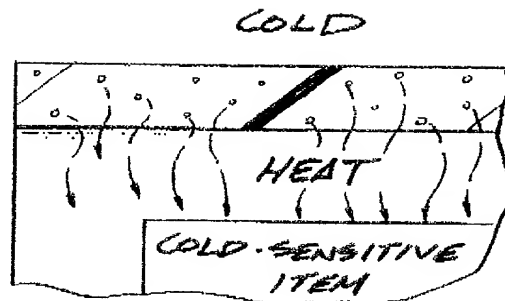


FIG. 17b

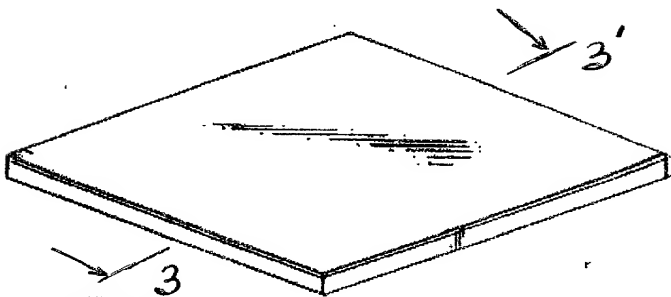


FIG. 18

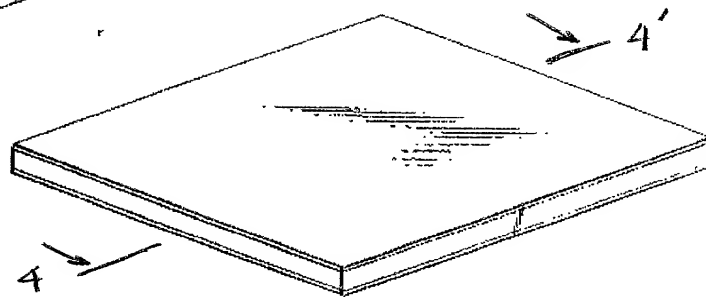


FIG. 19

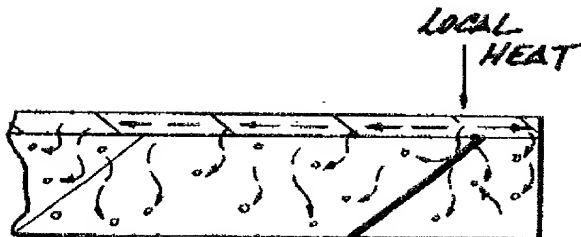


FIG. 20

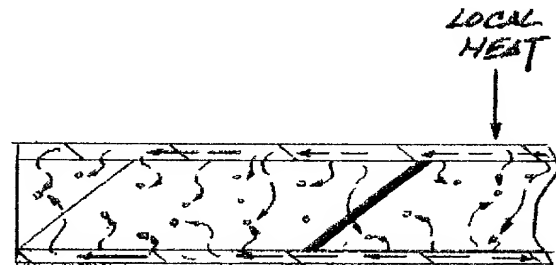


FIG. 21

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bp (PATFORMS)

Docket: P-5534-27

DECLARATION, POWER OF ATTORNEY AND PETITION

As a below named inventor, I hereby declare:

That my residence, post office address and citizenship are stated as below next to my name, that I declare that I am the inventor of the invention entitled: FLEXIBLE THERMAL CONTROL COMPOSITE, which is described and claimed in the attached specification and claims benefit from Provisional Application No. 60/143,722, filed July 14, 1999.

That I verily believe that I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural inventors are named below) of the invention described and claimed therein; and say that I have reviewed and understand the contents of the specification thereof, including the claims and drawings as amended by any amendment specifically referred to herein, that I do not know and do not believe that the same was ever known or used in the United States of America before my invention thereof or patented or described in any printed publication in any country before my invention thereof, or more than one year prior to this application, or in public use or on sale in the United States of America more than one year prior to this application, that said invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or any legal representatives or assigns more than six/twelve months prior to this application, that I acknowledge my duty to disclose information on which I am aware which is material to the examination of this application in accordance with 37 C.F.R. 1.56(a), and that no application for patent or inventor's certificate on this invention has been filed by me or my legal representatives or assigns in any country foreign to the United States of America except as follows: NONE, for which priority under 35 U.S.C. 119 is claimed.

And that I hereby appoint MURRAY SCHAFFER, Registration No. 18,671, PANAGIOTA BETTY TUFARIELLO, Registration No. 40,851 and PAUL J. HIGGINS, Registration No. 44,152, as my attorneys with full power of substitution, association and revocation, to sign the drawings, to prosecute this application and any and all foreign application, to make alterations and amendments therein, to receive the patent, and to transact all business in the Patent Office in connection therewith. Please address all correspondence to:

BAUER & SCHAFFER, LLP
114 Old Country Road
Mineola, New York 11501
(516) 248-1050

Wherefore I pray, that Letters Patent be granted to me for the invention described and claimed in the foregoing specification and claim, and I hereby subscribe my name to the foregoing specification and claim, declaration, power of attorney and this petition.

The undersigned petitioner declares further that all statements made herein of his own knowledge are true and that all statements made on information and belief are believed to be true; and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine and imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

DATE: 7/12/2000

SIGNED:

Claude Q.C. Hayes
Claude Q.C. Hayes
3737 Third Avenue, #308
San Diego, CA 92103
USA

P.O. Address/
and Residence:
Citizenship: